4.3 Building Codes for Energy Efficiency

Policy Description and Objective

Building energy codes for residential and commercial buildings lock in the benefits of cost-effective energy efficiency in new construction and major renovation of existing buildings.

Summary

Building energy codes require new and existing buildings undergoing major renovations to meet minimum energy efficiency requirements. Well-designed, implemented, and enforced codes can help eliminate inefficient construction practices and technologies with little or no increase in total project costs. Codes typically specify requirements for "thermal resistance" in the building shell and windows, minimum air leakage, and minimum heating and cooling equipment efficiencies. These simple measures can reduce energy use by 30% or more, resulting in cost savings for businesses and consumers. Building energy codes also reduce peak energy demand, air pollution, and greenhouse gas emissions. Recognizing these benefits, a majority of states have adopted building energy codes in some form for residential and commercial construction (DOE 2005).

Broadly speaking, building codes include an array of specifications and standards that address safety and functionality. In 1978, California became the first state to include energy requirements in its code. Today, 43 states (including Washington, D.C.) use a version of the Model Energy Code (MEC), the International Energy Conservation Code (IECC), or their own equal-or-better energy codes for residential buildings. Forty-one states (including Washington, D.C.) use the ASHRAE or IECC standard for commercial buildings (Prindle et al. 2003, BCAP 2005a).

While state and local governments have made progress in improving building efficiency through codes, there continue to be cost-effective opportunities for further efficiency savings. States with existing codes are conducting periodic updates and finding ways to improve compliance by monitoring, evaluating, and enforcing their codes. States without building energy codes are initiating stakeholder discussions and formal studies to evaluate whether codes make sense in their area. In some cases, local governments are adopting or modifying codes specific to their jurisdictional boundaries.

The potential energy savings from further state action can be significant. If all states adopted the most recent commercial and residential model energy codes, improved compliance levels, and applied model energy codes to manufactured housing, the United States would reduce energy use by about 0.85 quads annually, with cumulative savings through 2020 of about five quads. (One quad is about equal to the amount of energy contained in 167 million barrels of crude oil.) In 2020, annual consumer energy bill savings would be almost $7 billion, and the construction of 32 new 400 megawatt (MW) power plants could be avoided. Of course, each state's savings depends on many factors: the efficiency of its current building practices; the stringency of the code it adopts; its population, climate, and building construction activity; and the effectiveness of code training and enforcement (Prindle et al. 2003).

Objective

Building energy codes establish a minimum level of energy efficiency for residential and commercial buildings. This can reduce the need for energy generation capacity and new infrastructure while reducing energy bills. States are also finding that energy codes lock in future energy savings during the building design and construction process. In contrast, achieving post-construction energy savings can be comparatively expensive and technically challenging. Codes become even more cost-effective during periods of high heating and cooling fuel prices.

States and municipalities are updating existing codes, adopting new codes, and expanding code programs to improve compliance and achieve real energy and financial savings. With energy consumption expected to rise 20% in the residential sector and 19% in the commercial sector by 2020, enacting building codes is a key strategy for dampening growth in energy consumption across the buildings sector. Some states are promoting "beyond code" building programs to achieve additional cost-effective energy efficiency.

Benefits

State and local governments are seeing a range of benefits from building codes, including lower energy use, an improved environment, and economic growth. Each is discussed as follows.

Energy codes provide minimum levels of energy efficiency in commercial and residential buildings. This lowers overall energy consumption, provides energy bill savings, and can reduce peak energy demand and resulting pressure on the electric system. For example, California's building standards have helped save businesses and residents more than $15.8 billion in electricity and natural gas costs since 1975, and these savings are expected to climb to $59 billion by 2011 (CEC 2003). In addition, California's new 2005 building efficiency standards are expected to yield peak energy use reductions of 180 MW annually—enough electricity to power 180,000 average-sized California homes (Motamedi et al. 2004).

Why Building Energy Codes Help

Economic theory suggests that today's high energy prices should drive the new building market towards high levels of energy efficiency. However, states and municipalities are finding that market barriers sharply limit these effects, including:

- *Split Incentives*. Whereas builders typically bear the capital cost of energy efficiency improvements, homeowners and tenants see the benefits of lower energy bills. Since most builders do not occupy the building and pay energy bills, they lack an incentive to incorporate efficiency features that result in cost savings.
- *Customer Preferences*. Most home purchase decisions and feature selection is driven by nonenergy factors. In selecting optional features for the home, buyers often focus on amenities like kitchen upgrades, extra bathrooms, and new flooring. Efficiency competes with these priorities.

In the presence of multiple barriers, energy codes can ensure that new buildings achieve a basic level of energy efficiency performance that is cost-effective and delivers related benefits.

Residential and Commercial Building Energy Codes

The energy code that applies to most *residential* buildings is the IECC, which supersedes the MEC. The 2000 IECC is the most recent version for which DOE has issued a positive determination. However, different versions of the MEC/IECC have been adopted by states, creating a patchwork of residential codes across the country. The federal Energy Conservation and Production Act (ECPA) was amended in 1992 to require states to review and adopt the MEC (and its successor, the IECC), or submit to the Secretary of Energy its reasons for not doing so.

Most *commercial* building energy codes are based on ASHRAE/IESNA Standard 90.1, jointly developed by ASHRAE and the Illuminating Engineering Society (IES). ECPA requires states to adopt the most recent version of ASHRAE Standard 90.1 for which DOE has made a positive determination for energy savings, currently 90.1-1999. The IECC also contains prescriptive and performance commercial building provisions. By referencing Standard 90.1 for commercial buildings, IECC offers designers alternate compliance paths.

The American Council for an Energy-Efficient Economy (ACEEE) estimates that upgrading residential building codes could save an "average" state about $650 million in homeowner energy bills over a 30-year period (Prindle et al. 2003).

States and municipalities are also finding that energy codes improve the environment by reducing air pollution and greenhouse gases. For example:

- The New York Energy Conservation Construction Code (ECCC) reduces carbon dioxide (CO_2) emissions by more than 500,000 tons annually and reduces sulfur dioxide (SO_2) by nearly 500 tons per year (DOE 2002).

- The 2001 Texas Building Energy Performance Standards are projected to reduce nitrogen oxide (NO_x) emissions statewide by more than two tons each peak day and over one ton each average day, which helps the state meet Clean Air Act requirements for nonattainment areas (Haberl et al. 2003).

Building energy codes can also help grow the economy. States and municipalities benefit from greater investment in energy-efficient capital equipment and new jobs installing equipment and monitoring building compliance. While spending on energy services typically sends money out of state, dollars saved from efficiency tend to be re-spent locally (Kushler et al. 2005, Weitz 2005a).

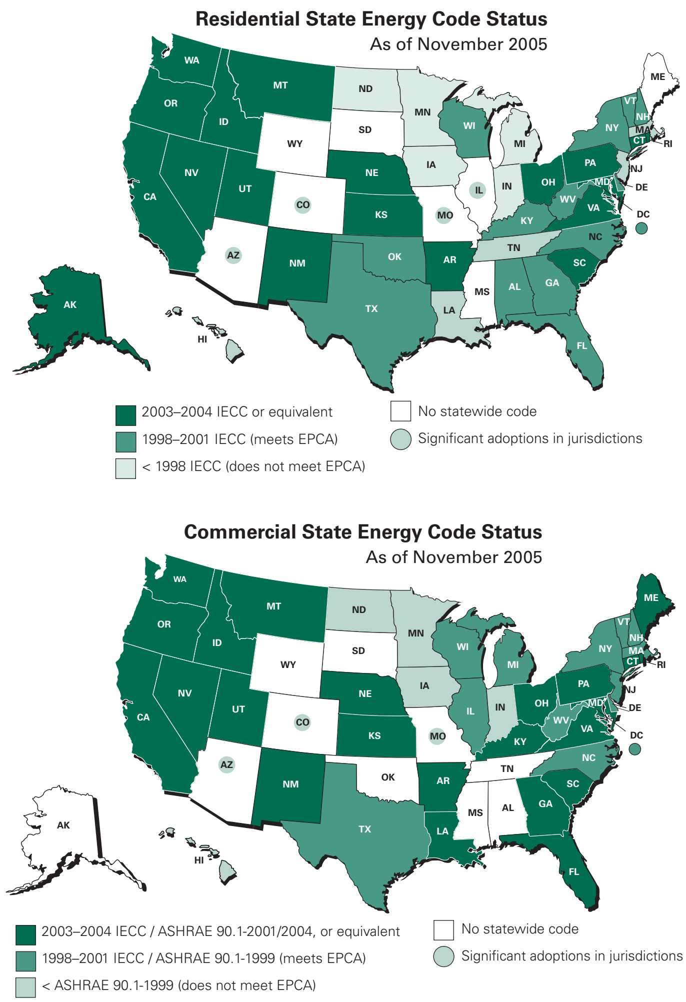
States with Building Energy Codes

As of November 2005, 43 states (including Washington, D.C.) use a version of the MEC, the IECC, or their own equal-or-better energy codes for residential buildings. Thirty-three of these 43 states are using the latest IECC version that the U.S. Department of Energy (DOE) has determined would improve the energy efficiency of residential buildings, or better. Only 10 states have not adopted a statewide code, although many jurisdictions in four of these states have adopted the 2003 IECC (Prindle et al. 2003, BCAP 2005a, Weitz 2005b).

A total of 41 states (including Washington, D.C.) use a version of the ASHRAE or IECC standard for commercial buildings. Thirty-six states are using the latest ASHRAE 90.1 standard for which DOE has made an energy efficiency determination, or better. Ten states have not adopted a commercial building code, although many jurisdictions within three of these states have adopted the 2003 IECC. While substantial progress has been made, many states and municipalities are regularly finding new opportunities to incorporate new technologies and features into their codes (Prindle et al. 2003, BCAP 2005a, Weitz 2005b).

State and local government experience demonstrates that policy adoption is only the first step—proper

Figure 4.3.1: States with Residential and Commercial Building Energy Codes



Source: BCAP 2005a.

implementation, evaluation, and enforcement are also necessary. In states where these components are missing, full compliance rates can fall short. For example, a 2001 study showed that compliance of less than 50% in the new homes market can occur even in states with strong code training programs (XENERGY 2001).

Leading states are not only monitoring and evaluating their energy codes, but also using the findings from these analyses to take corrective action. In California, a field evaluation of air conditioning units found that incorrect levels of "refrigerant charge" were compromising energy performance. The 2005 Title 24 Standards correct this problem by requiring verification of proper charge quantities by a home energy rater or documentation that a thermal expansion valve was installed (CEC 2005b). This illustrates the importance of maintaining active support for a range of evaluation and enforcement programs after codes are adopted into law.

Most states and municipalities periodically update their building energy codes, some more frequently than others. This process ensures that codes reflect changes in technology and design that offer increased energy efficiency and cost-effectiveness. Across states, it is common for code reviews to be triggered by the release of a new national model code or DOE's determination of improved energy efficiency. Some jurisdictions even introduce state- or local-specific requirements into the model code development process, sharing their experiences nationally.

Designing an Effective Building Code

Actions that states take when adopting new or updating existing codes include identifying key participants, analyzing cost considerations, determining a time frame for action, and evaluating interactions with other state and federal policies.

Participants

- *Government Officials*. Model building energy codes for the residential and commercial sectors are developed at the national level by model code organizations, such as the International Code Council (ICC) and ASHRAE. States and large local jurisdictions have been the predominant backers and participants in maintaining these model codes. DOE is required by the ECPA to participate in the review and modification of the codes. Code implementation is conducted at the state and local levels and enforced by local governments (DOE 2005). States often modify the national model codes to account for needs and opportunities specific to their climate, geography, and economy.

ECPA requires DOE to make determinations regarding national model codes. This means that DOE periodically evaluates new editions of the model codes (the IECC and Standard 90.1) and determines whether the new edition will improve the efficiency of residential or commercial buildings. If DOE makes a positive determination on a new residential model code, states must *consider* adopting it within two years. If they elect not to adopt the code, state officials are required to submit their reasoning to the U.S. Secretary of Energy. In contrast, if DOE makes a positive determination on a new commercial sector code, states are required to adopt it within two years. In practice, however, states demonstrate compliance through a self-certification process and there are no major repercussions for failing to adopt new commercial codes.

Under ECPA, DOE also provides technical and grant assistance to states to facilitate building code adoption and implementation. DOE operates through centers of expertise such as the Pacific Northwest National Laboratory (PNNL) to help states chart a course of action. Examples of PNNL technical assistance include conducting studies of current building practices (to develop baselines), quantitative analysis of potential benefits, legislative and regulatory assessments, training and technical assistance for builders and code officials, and other services available at: http://www.energycodes.gov.

More recently, the Energy Policy Act of 2005 (EPAct 2005) amended ECPA to authorize DOE to provide funding for states that implement a plan to achieve 90% compliance with residential (IECC 2004) and commercial (ASHRAE 90.1-2004) building codes. In states without a building code, DOE is authorized to provide similar funding to local governments that are taking action on building codes.

While most states have the authority to adopt energy codes statewide, some states have "home rule" laws that limit their ability to impose building requirements on municipalities. In these states, local governments can adopt their own codes. For example, two Arizona cities, Phoenix and Tucson, are taking this approach (and thereby affecting a large portion of the state's overall building stock). Alternatively, home rule states can revise existing law to allow for statewide building energy codes. Texas followed this approach, primarily in an effort to improve the state's air quality.

- *Builders, Developers, and Building Owners.* Builders, developers, and building owners are responsible for implementing provisions in the code language. States and municipalities are finding that active collaboration with these groups improves understanding, creates buy-in, and can lead to greater levels of compliance. States such as California, Minnesota, and Florida have a history of working closely with the building community (Prindle et al. 2003).
- *Code Developers.* In the United States the ICC, ASHRAE, and the National Fire Protection Association (NFPA) develop model energy codes and standards. The ICC develops the IECC for residential buildings, while ASHRAE maintains the 90.1 standards for commercial buildings and 90.2 for residential buildings. Both ICC and NFPA provide a reference to ASHRAE Standard 90.1 as an alternate compliance path for commercial buildings. To facilitate ease-of-adoption by states, these documents are written as model codes that can be adopted as is, or modified to suit state or local needs. Another role for code developers is to provide training and technical support to code officials. The ICC serves in this capacity to assist with interpretation and implementation of residential codes.
- *Nongovernment Organizations.* Nongovernment organizations support building energy code adoption and implementation by fostering peer exchange, serving as information sources, and providing expert assistance. For example, the Building Codes Assistance Project (BCAP) offers tailored technical assistance to states and municipalities. In states seeking to adopt the IECC or ASHRAE 90.1, BCAP provides services such as educational support for code officials and legislators, as well as implementation assistance. The organization is a joint initiative of the Alliance to Save Energy (ASE), ACEEE, and the Natural Resources Defense Council (NRDC).

The Residential Energy Services Network (RESNET) promotes codes by fostering national markets for home energy rating systems and energy-efficient mortgages that go beyond codes. RESNET develops home energy rating systems, accredits home energy rating trainers and providers, promotes residential energy efficiency financing products, and conducts educational programs. To encourage consistency across rating systems, the organization works to align its standards to the IECC.

Cost Considerations

Upgrading the energy efficiency of new homes and commercial buildings is very cost effective. A recent study estimated that upgrading the energy efficiency of a typical new home to comply with the model energy code in Nevada would cost about $1,500 on average but would result in about $400 in annual energy bill savings, meaning a simple payback of less than four years. Likewise, this study estimated that upgrading the energy efficiency of commercial buildings to comply with the code would cost about $1.60 per square foot but would result in about $0.68 per square foot of energy bill savings per year, meaning a simple payback of about 2.4 years (Geller et al. 2005).

The efforts of national code development organizations ensure that each state does not incur the full cost of developing its own codes. The ICC, ASHRAE, and NFPA offer model energy codes that are developed with stakeholder input and written to promote transferability. However, some states (e.g., California and Florida) and municipalities choose to initiate their own code development process. Although most find that using model codes saves the expense and time of developing a new code, it is common for states to initiate a review-and-modification process that amends the model codes to reflect state-specific considerations. Another way that state and local governments lower costs is by using technical and grant assistance from DOE and nongovernment organizations to fund their code development, adoption, or enforcement process.

When adopting a model code, states typically provide resources to municipalities to support implementation and enforcement. Local funds are used to help code officials and builders understand and comply with the code's requirements. Municipalities also lower costs by using home energy rating systems (HERS) to demonstrate compliance with the energy code. These systems indicate the energy efficiency of a home and are typically funded by the local government or the builder.

However, even where state and federal resources are available to municipal code officials, cities are finding that staff coverage for code enforcement is often stretched thin. To overcome this barrier, some local governments collaborate with state officials to help meet resource and assistance needs. For example, the Texas Energy Partnership is a consortium of state, federal, and local agencies—as well as universities and other non-government partners—created to help municipalities throughout Texas establish procedures for administration and enforcement of code requirements adopted under Senate Bill 5 (S.B.5). The partnership offers technical assistance and access to state and federal experts that help municipalities comply with code provisions and save money on energy bills (AACOG 2005).

Timing and Duration

State and local experience with building energy codes shows that the time of building design and construction represents a low-cost opportunity to integrate energy efficiency into a structure. Decisions made at this time often cannot be remedied later or can only be revised at significant cost.

States are also finding they can increase code effectiveness by regularly updating code specifications. A periodic review of energy code requirements is a strategic way to ensure that opportunities associated with new building sector technology are captured. States often time their reviews to coincide with updates of national-level model codes by the code development organizations or the issuance of a DOE determination. This approach offers regular opportunities for states and municipalities to simultaneously provide input to the model code development process and to update their own codes. Other states call for updates on a regular basis. For example, Massachusetts reviews its code every five years while some other states do so every three years (e.g., California, Idaho, Maryland, Montana, New Mexico, and Pennsylvania). As a rule of thumb, states take action if the code is more than five years old, if there is no evidence of consistent enforcement, or if there is no state energy code.

When code development organizations release a new version of a model code (and DOE makes a positive determination about its effectiveness), states are required by the Energy Conservation and Production Act (EPCA) to respond accordingly. On the residential side, new versions of the IECC are released every three years with an interim supplement released in between. While adoption is not required for residential codes, it is mandatory for new versions of the commercial sector ASHRAE 90.1 code. ASHRAE 90.1 has historically been revised and republished less frequently than the IECC (there was a decade gap between the 1989 and 1999 versions). It is now scheduled for release on a three-year cycle. The most recent version is 90.1-2004.

State experience with the review and update process demonstrates that it is important to anticipate and plan for the education and training needs of code officials, builders, contractors, and other affected parties. Each participant requires a period of time to identify and understand new requirements and changes to existing regulation. Code changes also affect product manufacturers and suppliers, who need lead-time to clear current inventories and ensure that newly compliant products are available when the revised code takes effect.

Interaction with Federal Programs

State and local governments are finding that voluntary programs such as ENERGY STAR can help the building community move beyond code-mandated efficiency levels in the new housing stock. An ENERGY STAR-qualified new home is at least 30% more efficient than a home built to the model energy code

Best Practices for Developing and Adopting Building Codes

States and municipalities have identified the following best practices to help states update existing building energy codes and adopt new codes:

- *Do Your Homework.* Evaluate current building energy code laws, as well as options for implementation and enforcement. If there is no state energy code, if it is more than five years old, or if there is no evidence of consistent enforcement, it may be time to act:
  - Conduct an analysis of the benefits and costs of code adoption and implementation.
  - Talk with key stakeholders—including local officials and builders—to hear their concerns, assess their experience with energy codes, and gauge their perspectives.
  - Assess resources for training and other forms of technical support for code officials, builder associations, and building supply organizations.
  - Contact materials suppliers to learn about availability of compliant products.
- *Obtain Outside Help.* Implementing and enforcing codes requires a high level of engineering expertise that many code officials do not have. Several organizations provide resources to help. For example, DOE's Pacific Northwest National Laboratory, the Building Codes Assistance Project, and the New Buildings Institute can assist in charting a course of action. This action might include quantitative assessments of potential benefits, baseline building practice studies, legislative and regulatory assessments, training and technical assistance for builders and code officials, and other services.
- *Create a Stakeholder Process.* Involve key stakeholders early and regularly. Include them in reviews of studies, proposal regulations, and other aspects of the process. Involving stakeholders helps ensure the codes are appropriately designed. This process increases the chances of code adoption and minimizes enforcement problems.

and 15% more efficient than one built to local code. To certify an ENERGY STAR home, the builder may guide construction to this performance specification—as verified by a HERS—or build to a prescribed set of requirements outlined in a Builder Option Package (BOP). BOPs contain requirements for insulation levels, air infiltration, windows, and heating and cooling equipment. The relevant set of BOP requirements depends on climate conditions and is third-party verified.

To encourage the construction of ENERGY STAR-qualified new homes, state and local governments are using marketing and outreach campaigns, training builders, and assisting builders in rating their homes. New York's Energy $mart initiative has an active ENERGY STAR new homes program that emphasizes education and training for builders, local officials, and other stakeholders. Since its inception in 2001, more than 4,000 homes have been constructed and qualified in the state. New York is finding that voluntary above-code programs complement and go beyond traditional regulatory approaches to ensure a continuous stream of building energy savings (New York Energy $mart 2005).

Interaction with State Policies

State and local policymakers are leveraging other state clean energy policies to support building energy codes. For example, some states are using public benefits funds (PBFs) to support code implementation and enforcement. The New York State Energy Research and Development Authority (NYSERDA) offers financial incentives to building owners and leaseholders to improve the energy efficiency of new and existing construction (NYSERDA 2004). Other states, such as Illinois and Wisconsin, are using PBF resources to enhance voluntary new and existing buildings programs used to document code compliance (MEEA 2002).

Several state and local governments are investigating the extent to which building codes improve air quality, and whether this benefit can be incorporated into their air quality planning process. Codes improve air quality by reducing energy consumption in buildings, thereby lowering electricity generation and resulting pollution from power plants. In some states and cities, code officials are beginning to collaborate with air quality planners on how these benefits can be captured in State Implementation Plans (SIPs) for regulated air pollutants. S.B.5 in Texas is an example of legislation mandating building energy efficiency for the explicit purpose of improving the state's ozone air quality (see *State Examples* section on page 4-46).

Program Implementation and Evaluation

Implementation

States and municipalities are finding innovative ways to implement building codes and achieve significant savings. By addressing the following commonly encountered barriers, they can increase their likelihood of success:

- *The Size and Fragmentation of the Building Industry Slows Technology Advancement*. While there are fewer than a dozen U.S. manufacturers of automobiles, home appliances, and light bulbs, there are approximately 150,000 home building companies in the United States. And in contrast to highly automated sectors of the U.S. economy, the building sector remains largely a craft industry dependent on the integration of hundreds of components from various manufacturers by onsite crews and subcontractors. To overcome this barrier, many states provide training and education services to these groups. For example, the Texas State Energy Conservation Office (SECO) works in partnership with the Texas Association of Builders to provide classroom and online training for homebuilders and subcontractors. Their program focuses on the importance of well-designed and properly installed energy and moisture management systems. Outreach materials are available in both Spanish and English.
- *Energy Efficiency Is Typically Not a Top Customer Preference*. This can serve as a barrier to code implementation and enforcement (though not necessarily code adoption). Most home purchase decisions and feature selection are driven by non-energy factors. For example, buyers are often more focused on amenities like kitchen upgrades, extra bathrooms, or new flooring. Efficiency features compete with these highly visible priorities.

  In states where energy efficiency is not a top customer preference, it is often because awareness is low. Evidence from a Massachusetts energy code evaluation indicates that homebuyers rarely ask builders about the beneficial energy efficiency characteristics of their prospective homes (XENERGY 2001). By inquiring about measures such as proper heating, ventilation, and air conditioning (HVAC) equipment sizing and duct insulation, consumers can avoid problems such as high utility bills, poor ventilation, differential heating and cooling of rooms in the house, and reduced comfort. Since consumers drive the market, some states are turning to education as an important component of code implementation efforts.
- *Surveys Indicate That Mandatory Energy Codes Are Often Not Complied With Because They Are Too Complex and Difficult to Understand*. As a result, states are finding that having an energy code in place is no guarantee that energy savings will be achieved. Code-development organizations are responding to this barrier by simplifying new versions of the ASHRAE 90.1 standards and IECC. For example, the 2004 version of ASHRAE Standard 90.1 included updated HVAC equipment efficiency levels that reflect new federal manufacturing standards. In the residential sector, the 2006 IECC is about one-half the size of the 2003 edition. In addition, there is no longer a "window-to-wall ratio" requirement, a provision that many found overly complex. Instead, the envelope criteria (i.e., amount of insulation and window characteristics) are independent of the amount of glazing. Another change to both codes is that they now contain a simplified approach to characterizing climate zones, reducing the overall number from 19 to 8. Each zone is now a distinct geographic block aligned by political boundaries to facilitate code implementation and enforcement (ICC 2005).
- *States Are Also Taking Steps to Reduce the Complexity of Their Codes*. They are finding that effective prescriptive codes—such as the model adopted by Oregon and Washington—are written in straightforward language that emphasizes simple measures with high energy savings potential. Code officials are also pursuing a range of best practices (see text box, *Best Practices for Energy*

Code Implementation) that minimize the additional learning and time requirements imposed on code officials.

- *According to the National Science Foundation and the Lawrence Berkeley National Laboratory (LBNL), Many States Do Not Possess the Necessary Resources to Monitor, Evaluate, and Enforce Their Energy Code.* Some states have less than one full-time-equivalent staff person dedicated to enforcement, and many states simply do not pursue monitoring and evaluation (DOE 2005). As a result, self-enforcement of building energy code provisions is the norm in many states. New York accomplishes this by requiring a licensed design professional to complete an official form attesting to code compliance.

  Other states are using PBF funds to address the challenge of moving from the process of code adoption to widespread compliance. For example, California's Public Interest Energy Research (PIER)—funded by ratepayer dollars to conduct energy research and development for the state—works to identify candidate technologies and practices for improving the energy efficiency of new buildings in California. Currently, PIER is funding projects to support the development of California's 2008 Residential Building Energy Efficiency Standards (Eash 2005, CEC 2005a). In the face of resource shortages, other states rely on self-enforcement mechanisms such as home energy rating systems and the ENERGY STAR program.

Evaluation

State and municipal experience demonstrates that evaluating energy savings, conducting compliance surveys, and assessing the process by which program information is distributed are key elements of a successful building energy code. Evaluation of energy and peak demand savings data helps ensure requirements are followed and that stated goals are achieved. Information about the "co-benefits" of energy savings (e.g., financial savings and reductions in air pollution), implementation levels, and code awareness is used by code officials to evaluate progress, suggest strategies for improvement, and enhance overall program effectiveness.

Best Practices for Energy Code Implementation

States and municipalities have identified the following best practices for energy code implementation:

- Educate and train key audiences:
  - Build strong working relationships with local building officials, homebuilders, designers, building supply companies, and contractors for insulation, heating, and cooling equipment.
  - Hold regular education and training sessions before and after the effective date of the new energy code requirements. Maintain an ongoing relationship with homebuilders and building officials associations, even between code change cycles. This encourages both familiarity and trust and is an opportunity to share concerns.
- Provide the right resources, including:
  - An overview of energy code requirements, opportunities, and related costs and benefits.
  - Basic building science concepts. Practical compliance aids can range from laminated information cards for simple prescriptive methods to software packages for performance-based codes.
  - Information on how to inspect plans and site features for compliance.
  - Who to contact and resources for more information and technical assistance.
- Provide budget and staff for the program. Assign staff personnel with appropriate training and experience to support the code adoption and implementation processes. Provide this person with sufficient budgets to do the necessary homework, involve stakeholders, and support implementation.

Similarly, states are conducting studies of prospective energy savings from codes prior to adoption and implementation. Measuring the range of potential benefits—energy, economic, and environmental—can build the case for energy codes by assessing both positive and negative costs. If results show promise, studies of prospective benefits can also broaden stakeholder support for energy codes.

State and local officials are finding value from the following kinds of evaluation tools:

- *Energy Savings Evaluation.* Even though theoretical energy savings from building codes can be estimated with computer software, it is important to evaluate whether codes are actually saving energy and meeting goals. Information from energy savings evaluations can be used to determine if certain portions of the code perform better than others or if overall savings are meeting expectations. With this insight, states can focus their implementation and enforcement efforts on addressing priority concerns. For example, a 2002 study in Fort Collins, Colorado found that measured energy savings from a code change in 1996 were approximately half of pre-implementation estimates. By conducting a code evaluation, the city was able to identify problem areas and focus its resources accordingly (City of Fort Collins 2002).
- *Compliance Surveys.* These are used to determine whether buildings are being built in compliance with code. If they are not, additional enforcement and training initiatives may be needed. Another purpose of surveys is to assess the overall state of building technology and practice. Survey results might show, for example, that certain beyond-code energy features are gaining wide acceptance in the market due to improved cost-effectiveness.
- *Process Evaluation.* State programs that offer technical assistance and related services benefit from a process evaluation to assess and suggest improvements to these offerings. These evaluations look less at what is being built than at the ways information is delivered to key stakeholders such as builders and code officials. Improving service delivery can help improve code compliance and overall stakeholder acceptance of the code. Process evaluation is also used to determine the effectiveness of a state's enforcement efforts.

State Examples

The following states have implemented successful building codes programs using varying approaches.

California

California's Title 24 standards for residential and commercial buildings are among the most stringent and best-enforced energy codes in the United States. The building code provisions of Title 24 are notable for:

- *Stringency.* The Title 24 standards typically exceed IECC and ASHRAE efficiency levels.
- *Performance-Based Provisions.* California's building efficiency standards are organized into three basic components: mandatory features, prescriptive package requirements, and performance guidelines.
- *High Compliance Rates*. Field verification studies for Title 24-compliant buildings show that 70% of homes meet all code requirements.
- *Flexibility.* California is one of a few states that includes a performance-based approach that permits a wide variety of combinations of energy efficiency measures to meet code requirements.
- *Receiving Active Support.* The California Energy Commission (CEC) maintains an expert staff that manages the code development process and provides technical assistance in code interpretation and enforcement.
- *A Forward-Looking Orientation.* California periodically expands the scope and stringency of its energy codes to ensure that they capture available "potential savings" and works with its utilities on research and development to incorporate proven technologies.

California's new 2005 building efficiency standards are expected to yield $43 billion in electricity and natural gas savings by 2011. Forecasts estimate that the standards will reduce annual energy demand by 180 MW, equivalent to the electricity requirements of 180,000 average-sized California homes (CEC 2003). The CO_2 savings in the residential sector alone is 49,000 tons per year, a figure equivalent to 9,600 passenger cars not driven for one year (USCTCG 2005).

Web site:
http://www.energy.ca.gov/title24/

Oregon and Washington

Compared to California, the states of Oregon and Washington take a simpler and more prescriptive approach to building energy efficiency. Their strategy is closely aligned to the Model Conservation Standards (MCS) developed in the Northwest region during the 1980s. The MCS were originally disseminated as voluntary standards under utility programs that offered incentives, education, and other support to builders. As builders came to accept the MCS, states in the region moved to incorporate them into building codes.

The simplicity and consistency across local jurisdictions of Oregon and Washington's prescriptive approach has achieved a high level of code compliance. A recent construction practice survey found that 94% of homes surveyed in Washington and 100% in Oregon met or exceeded code requirements for the building envelope (Ecotope 2001).

Residential energy codes in Oregon saved 857 million kilowatt-hours (kWh) and 40 million therms of natural gas in 2000 (Oregon Office of Energy 2001).

Web sites:
http://egov.oregon.gov/ENERGY/CONS/Codes/codehm.shtml

http://www.energy.wsu.edu/code/default.cfm

Texas

Texas is a "home rule" state that passed legislation in 2001 requiring local governments to follow a single statewide building energy code. It is also the first state to adopt an energy code primarily for Clean Air Act compliance reasons. After extensive stakeholder consultation, the state elected to adopt the IECC, including a solar heat gain standard for windows that results in significant cooling and peak load energy savings. The following are key features of the Texas code:

- The IECC's cooling energy savings are substantial. Electricity reductions from the solar heat gain standard alone will total 1.8 billion kWh over 20 years and avoid 1,220 MW of peak demand at the end of the 20-year period (Tribble et al. 2002).
- The Texas energy code is approved for 0.5 tons per day of NO_x emissions credits from EPA in the SIP for ozone pollution. This is the first time that an energy code has been adopted by a state specifically to improve air quality.
- Because Texas is a home rule state, it has limited ability to impose regulatory requirements on local jurisdictions. Successful implementation of a single statewide energy code is a political milestone.

Web site:
http://www.trcc.state.tx.us

Arizona

Arizona is another home rule state where energy codes are adopted and enforced at the local level. As such, several communities—including Pima County and the city of Tucson—have emerged as local leaders in building code adoption. Both jurisdictions now have codes based on the 2000 IECC. Another Arizona municipality, the city of Phoenix, recently conducted a comprehensive review and technical comparison of the national model building codes. After initiating a process to solicit stakeholder input, Phoenix pursued and adopted residential and commercial codes, making it the first city in the United States to adopt the IECC 2004 supplement for residential construction and the ASHRAE 90.1 2004 standard for commercial construction.

The successful experience of these municipalities has encouraged other local governments in Arizona to consider adopting an energy code. The Maricopa Association of Governments, a Council of Governments that serves as the regional agency for the Phoenix metropolitan area, is currently assessing the possibility of adopting building energy requirements for the more than 30 localities included within its jurisdiction (Panetti 2005).

Projected results from building codes programs include:

- By adopting the 2004 IECC, Phoenix is expected to reap an 18% reduction in residential energy consumption, a 21% reduction in electricity use, and a 10% in natural gas use.
- It is estimated that while a new home built to the IECC will cost an average of $1,517 more than a home built without the code, the difference will be repaid to homebuyers in 3.9 years (based on simple payback). The life cycle cost savings associated with improved energy efficiency from adopting the IECC is $11,228 per home (BCAP 2005b).

Web site:
http://www.commerce.state.az.us/energy/state%20energy%20code.asp

What States Can Do

States with energy codes can consider updates and improvements to the implementation process. States with no energy code in place can examine the costs and benefits of implementing a code and consider initiating a code adoption process.

Action Steps

States that already have an energy code can:

- Implement a rigorous enforcement program that ensures local building code departments have proper training and resources, including adequate staff coverage.
- Review the version of the document currently in force. If it is more than five years old, consider an updated version. The latest available IECC code version is the 2006 version, which was released in October 2005. The most recent ASHRAE Standard 90.1 is the 2004 version.
- Conduct analysis on the effect of potential code updates on energy and cost savings for building owners, on the effect on energy generation and distribution, and on air pollutant and greenhouse gas emissions levels. Balance these benefits against any added construction costs.
- Initiate a stakeholder process to review the data, obtain participant input, and decide whether to adopt a new code.
- If a new version of the energy code is adopted, initiate administrative and educational processes. Implementation tools and other resources are available at no charge from DOE.
- If a state-specific energy code training program exists, review it and consider an update that describes new codes not currently covered.

States that are considering adopting an energy code can:

- Review all available model codes and standards and learn about other states' experiences. Conduct research and analysis to determine which codes best match the needs of the area under consideration.
- Establish a baseline building prototype against which to assess the benefits of an energy code. This may require a field survey of homebuilders, suppliers, and contractors, including onsite inspections and interviews.
- Conduct an analysis of the effect of the new code on energy and cost savings for building owners, power system reliability, and reduced air pollutant and greenhouse gas emissions. Balance these benefits against any added construction codes.
- Initiate a stakeholder process to review the data, obtain stakeholder input, and decide whether to adopt the energy code under consideration.
- After a decision to adopt an energy code, initiate administrative and educational processes, as appropriate.
- Develop a code implementation process that includes training and technical assistance. Reach out to affected industries and audiences across the state.

Information Resources

Information About Individual State Codes

Title/Description/Contact Information	URL Address
BCAP. A nonprofit organization, BCAP is dedicated to helping states adopt and implement up-to-date building energy codes. The BCAP Web site includes maps, data on code status for all states, and information on training opportunities.	http://www.bcap-energy.org
Building Energy Codes Program Web Site: Case Study: Massachusetts Commercial Energy Code. This Web site includes highlights of the Massachusetts Commercial Energy Code and details of the collaborative code adoption process along with projected energy and cost savings and pollution reduction.	http://www.energycodes.gov/implement/case_studies/massachusetts.stm
Building Energy Codes Program Web Site: Case Study: New York Energy Conservation Construction Code. This Web site includes an overview of the New York Energy Conservation Construction Code and the code adoption process, and also details some of the reasons for the code's success.	http://www.energycodes.gov/implement/case_studies/new_york.stm
California: CEC. Phone: 916-654-5106 or 800-772-3300 (toll free in California). E-mail: title24@energy.state.ca.us.	http://www.energy.ca.gov/title24
DOE Status of State Energy Codes. This Web site provides data for each state on state contacts, current code status, code history, and construction data.	http://www.energycodes.gov/implement/state_codes/index.stm
Florida: Department of Community Affairs. Codes & Standards Office 2555 Shumard Oaks Blvd. Tallahassee, FL 32399-2100 Phone: 850-487-1824.	http://www.floridabuilding.org
Minnesota: Building Codes and Standards Division 408 Metro Square Building 121 7th Place East St. Paul, MN 55101 Phone: 651-296-4639.	http://www.state.mn.us/cgi-bin/portal/mn/jsp/home.do?agency=BCSD or http://www.state.mn.us/cgi-bin/portal/mn/jsp/content.do?subchannel=-536886620&id=-536886617&agency=BCSD
Oregon Office of Energy 625 Marion St. NE Salem, OR 97301-3737 Phone: 503-378-4040 or 800-221-8035 / Fax: 503-373-7806 E-mail: energyweb.incoming@state.or.us.	http://egov.oregon.gov/ENERGY/CONS/Codes/codehm.shtml
Texas A&M Energy Systems Laboratory (ESL) ESL Senate Bill 5 Program Room # 053 Wisenbaker Engineering Research Center Bizzell Street Texas A&M University College Station, TX 77843-3581 Phone: 979-862-2804 / Fax: 979-862-2457.	http://165.91.209.42/sb5/workshops/training.htm
Washington State Energy Extension Service 925 Plum Street SE Bldg No 4 Box 43165 Olympia, WA 98504-3165 Phone: 360-956-2000 / Fax: 360-956-2217.	http://www.energy.wsu.edu/code/default.cfm

Other Resources for Building Code Information

Title/Description	URL Address
ASHRAE. ASHRAE provides technical standards and other technical information.	http://www.ashrae.org/
BCAP. A nonprofit organization, BCAP is dedicated to helping states adopt and implement up-to-date building energy codes.	http://www.bcap-energy.org/
Codes and Standards: MEC. The MEC is published and maintained by the ICC. The 1998 IECC is the successor to the 1995 MEC.	http://www.energycodes.gov/implement/pdfs/modelcode.pdf
DOE BECP. Operated by PNNL, BECP provides compliance tools, technical assistance, and other code information and support.	http://www.energycodes.gov
ICC. The ICC provides code documents, technical assistance, training, and other services.	http://www.iccsafe.org
New Buildings Institute (NBI). A nonprofit organization, NBI develops leading-edge commercial building standards and related research and technical information.	http://www.newbuildings.org/
RESNET. RESNET accredits home energy rating organizations, and provides a variety of technical information on home energy ratings and home energy performance.	http://www.natresnet.org/

Compliance and Analytical Tools

Title/Description	URL Address
DOE Building Energy Tools Directory. This is the DOE directory of building energy analysis tools.	http://www.eere.energy.gov/buildings/tools_directory/
DOE COMcheck-EZ and REScheck Software. Provided through the DOE codes program, these simple programs offer an easy way to check whether a wide variety of building designs meet energy code requirements.	http://www.energycodes.gov/compliance_tools.stm
DOE EnergyPlus. This public-domain software provides accurate building energy simulation capabilities.	http://www.eere.energy.gov/buildings/energyplus/
ENERGY STAR Portfolio Manager. This tool allows users to track energy use of a portfolio of buildings online. It includes functions for benchmarking, managing a single building or group of buildings, assessing investment priorities, and verifying building performance.	http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager
ENERGY STAR Target Finder. This tool rates the energy performance of a building design using information about energy use per-square-foot derived from building design simulation tools. EPA's energy performance rating system uses a 1 to 100 scale, where an ENERGY STAR target rating is 75 or higher.	http://www.energystar.gov/index.cfm?c=target_finder.bus_target_finder

Examples of Code Language

State	Title/Description	URL Address
Arizona	Arizona State Energy Code; Advisory Commission (voluntary).	http://www.azleg.state.az.us/ars/41/01511.htm
	Proposed Amendments to IECC.	http://phoenix.gov/DEVSERV/ieccamd.pdf
	Sustainable Energy Standard for the IECC, 2000 edition, regionally specific for the Tucson Metropolitan Area.	http://www.ci.tucson.az.us/dsd/Codes___Ordinances/Building_Codes/2000IECCSES_sustainable_energy.pdf
California	California State Legislature, AB 970, Section 25553.	http://www.leginfo.ca.gov/pub/99-00/bill/asm/ab_0951-1000/ab_970_bill_20000907_chaptered.html
	2001 Energy Efficiency Standards for Residential and Nonresidential Buildings.	http://www.energy.ca.gov/title24/2001standards/2001-10-04_400-01-024.PDF
Oregon	Oregon Revised Statutes, 455.525.	http://www.leg.state.or.us/ors/455.html
	Oregon Department of Energy, Energy Code Publications and Software.	http://egov.oregon.gov/ENERGY/CONS/Codes/cdpub.shtml
Texas	Texas Residential Building Guide to Energy Code Compliance.	http://165.91.209.42/sb5/documents/ResGuideRev104.pdf
	Texas State Legislature, SB 5–Legislative Session 77(R), Chapter 388.	http://www.capitol.state.tx.us/statutes/docs/HS/content/htm/hs.005.00.000388.00.htm
Washington	**Washington State Legislature, WSR 05-01-013.** Enter "05-01-013 " in *Search Bills, RCW, WAC, and State Register box* and check "State Register 2005."	http://search.leg.wa.gov/pub/textsearch/default.asp
	Washington State Building Code Council, State Building Codes.	http://www.sbcc.wa.gov

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BCAP. 2005a. BCAP Web site. Providence, RI.	http://www.bcap-energy.org/
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CEC. 2005a. 2004 Annual Review of the PIER Program, Volume 2: Residential and Commercial Buildings End-Use Efficiency Project Summaries. CEC-500-2005-055-V2. March. CEC.	http://www.energy.ca.gov/2005publications/CEC-500-2005-055/CEC-500-2005-055-V2.PDF
CEC. 2005b. 2005 Building Energy Efficiency Standards for Residential and Non-Residential Buildings. P400-03-001F-M. October 1. CEC.	http://www.energy.ca.gov/title24/2005standards/2004-12-13_400-03-001FM.PDF
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DOE. 2005. State Energy Alternatives: Energy Codes and Standards. Energy Efficiency and Renewable Energy Web site. U.S. Department of Energy, Washington, D.C.	http://www.eere.energy.gov/states/alternatives/codes_standards.cfm
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ICC. 2005. International Code Council Web Site: News.	http://www.iccsafe.org
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4.4 State Appliance Efficiency Standards

Appliance standards save energy and generate net benefits for homes, businesses, and industry by reducing the energy cost needed to operate equipment and appliances.

Policy Description and Objective

Summary

State appliance efficiency standards establish minimum energy efficiency levels for appliances and other energy-consuming products. These standards typically prohibit the sale of less efficient models within a state. Many states are implementing appliance and equipment efficiency standards, where cost-effective, for products that are not already covered by the federal government.[13] States are finding that appliance standards offer a cost-effective strategy for improving energy efficiency and lowering energy costs for businesses and consumers.

As of November 2005, 10 states (Arizona, California, Connecticut, Maryland, Massachusetts, New Jersey, New York, Oregon, Rhode Island, and Washington) have adopted standards for 36 types of appliances. Four states (Maine, New Hampshire, Pennsylvania, and Vermont) are considering adopting standards.

Appliance efficiency standards have been an effective tool for improving energy efficiency. At the federal level, the U.S. Department of Energy (DOE) has been responsible for setting minimum appliance standards and test procedures for an array of residential and commercial appliances and equipment since 1987. As of 2000, federal appliance efficiency standards had reduced U.S. electricity use by 2.5% and carbon emissions by nearly 2%. By 2020, the benefits from existing standards are expected to more than triple as the stock of appliances and equipment is replaced by more efficient models (Geller et al. 2001). The appliance standards for 16 products established by the Energy Policy Act of 2005 (EPAct 2005) are expected to yield an additional 2% savings in total electricity use (ACEEE 2005a).

Efficiency standards can play a significant role in helping states meet energy savings goals. In New England, for example, a package of state standards is expected to reduce load growth by 14% from 2008 to 2013 and cut summer peak demand growth by 33% (Optimal Energy 2004).

States are also finding that appliance standards have low implementation costs because the existing standards of states like California can be leveraged.

Objective

The key objectives of appliance efficiency standards are to:

- Raise the efficiency of a range of residential, commercial, and industrial energy-consuming products, where cost-effective.
- Overcome market barriers, such as split incentives between homebuilders and homebuyers and between landlords and tenants, and panic-purchase situations where appliances break and must be replaced on an emergency basis. In a panic purchase, customers usually don't have the time to consider a range of models, features, and efficiency levels.
- Ensure energy use reductions to prevent pollution and greenhouse emissions, improve electric system reliability, and reduce consumer energy bills.

13 Under certain conditions, states can exceed a federal standard for a federally covered product; overall, however, federal law is preemptive. For example, in the case of building codes, a state can create a building code compliance package in which a furnace is at a higher efficiency than the federal standard. However, the state must also provide a compliance path under which the higher-efficiency furnace is not required. Thus, the option to exceed federal standards is indirect and is typically only possible in the case of building codes. In addition, states cannot ban lower efficiency products.